

DISTRIBUTION OF VASCULAR HYDROPHYTES AND DESCRIPTION OF ASSOCIATED MACROFAUNAL COMMUNITIES IN SWAN BAY, VICTORIA

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ABSTRACT: The biomass of vascular hydrophytes in Swan Bay was measured at fifty sites. Macrofaunal distribution was examined at eleven intertidal sites. Five species of vascular hydrophyte were collected: *Heterozostera tasmanica*, *Zostera muelleri*, *Halophila ovalis*, *Lepilaena cylindrocarpa* and *Ruppia megacarpa*. The dominant species was *H. tasmanica* which was found at 90% of the sites and had a mean standing crop of 104 g dry weight m⁻². *Z. muelleri* and *L. cylindrocarpa* were restricted to the intertidal zone. *H. ovalis* was found only at subtidal sites and *R. megacarpa* was found only rarely. A total of 74 taxa of invertebrates was taken, the majority of which were detritivores (75%). Hierarchical analysis showed differences between sites covered with vascular hydrophytes and sites only sparsely covered. Fewer species were found associated with the latter sites. Community statistics were similar to those of other Australian seagrass communities. However, species composition of the Swan Bay community differed from other *H. tasmanica*-*Z. muelleri* communities, indicating that there is no 'typical' *H. tasmanica*-*Z. muelleri* benthic macrofaunal community.

While details of the distribution of various species of seagrass around the coast of Australia have been published (den Hartog 1970, McComb *et al.* 1981), little quantitative information is available on the invertebrate communities that these seagrasses support. Hutchings (1982) has reviewed the literature on the fauna of Australian seagrass ecosystems and, more recently, quantitative studies of the fauna of *Heterozostera tasmanica* (Martens ex Aschers.) den Hartog and *Zostera muelleri* Irmisch ex Aschers. communities in Westernport Bay, Victoria (Watson *et al.* 1984) and *Posidonia australis* Hook. f. communities along the coast of New South Wales (Collett *et al.* 1984) have been published.

This paper reports the distribution of seagrasses and other vascular hydrophytes in Swan Bay, Victoria, and some aspects of the associated fauna. Faunal studies concentrated on intertidal and shallowly-subtidal animal communities. A preliminary description of the seagrasses of Swan Bay has been published (Kerr 1982) but this is the first account to present quantitative information on the distribution of the seagrasses and their associated macrofauna in the Port Phillip Bay region.

Swan Bay (38° 14'S, 144° 40'E) is a shallow, soft-bottom embayment, with an area of approximately 3000 ha (Figs 1A, B). The sediments are clayey sands with shell fragments constituting nearly all the sand-sized particles (Beasley 1966). A major feature of the bay is an extensive series of intertidal mudbanks (Fig. 1B). Exchange with Port Phillip is limited to two navigable channels, a dredged channel south of Swan Island and a northern channel. Surface drainage of the catchment area on the western side of Swan Bay is confined to intermittently flowing creeks.

METHODS

Ten samples, each of 0.025 m² area, of vascular hydrophytes were taken from each of fifty sites during July-December 1978. The sites (Fig. 2) were randomly selected from an original grid of 500 such sites. Each site covered an area of approximately 6 ha and the position of samples within each site was determined by using random number tables. A quadrat was used to mark each sample and all plant material within this quadrat to a depth of 8-10 cm was collected. Samples were sorted and angiosperm species identified. Above and below ground parts were not separated. After rinsing in 5% phosphoric acid to remove epiphytes, the sorted samples were dried to constant weight and dry weights were determined.

Samples of benthic macrofauna were taken from eleven sites during May-August 1978. Sites (Fig. 2) were selected from intertidal areas of heavy seagrass growth. For comparison, two areas of sparse plant cover were also sampled. At each site, either six or ten random samples were taken from a marked 30 m square using a spade corer (area = 0.03 m²). Samples were washed on a 1 mm mesh sieve and preserved in 5% formalin-seawater solution. Samples were sorted and invertebrates were identified to the lowest possible taxonomic level and counted. For each site a number of community statistics were calculated: S, the total number of taxa per site; s, the number of taxa per sample; n, the mean number of individuals per sample; H', the Shannon-Weaver diversity index (to the base e); and, J', the evenness. For heavily-grassed sites, N, the total abundance of invertebrate taxa (No. m⁻²) also was calculated.

Hierarchical analysis was used to compare all sites. Two indices, Czekanowski's formula of faunal affinity

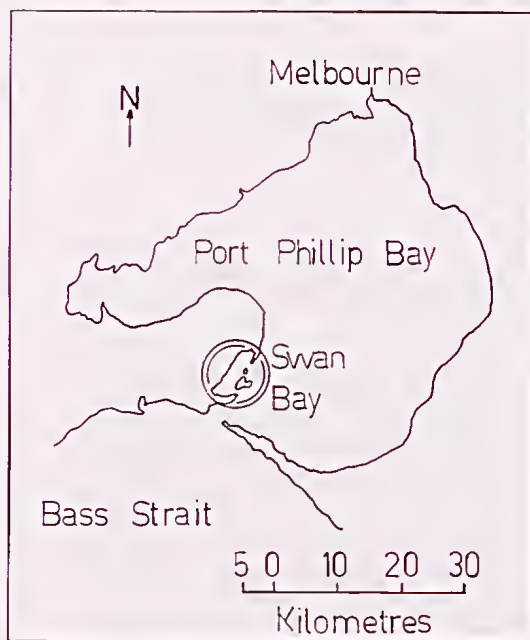


Fig. 1A—The general location of Swan Bay

and the Canberra metric coefficient of dissimilarity were used. The first index takes account of presence/absence data only, while the second also takes account of the numbers of each taxon present. A group averaging strategy was used to fuse the sites (Clifford & Stephenson 1975). Using the literature and observations in the field, taxa were assigned to feeding types: herbivores, omnivores, predators, scavengers, suspension feeders, unspecified or detritivores. The term 'detritivore' is used to include both sediment-ingesting deposit feeders and those organisms that consume larger detrital particles.

RESULTS

Five species of vascular hydrophytes were collected: *Zostera muelleri*, *Heterozostera tasmanica*, *Halophila ovalis* (R.Br.) Hook. f., *Lepilaena cylindrocarpa* (Kocernicke ex Walp.) Benth. and *Ruppia megacarpa* Mason. The dominant species in terms of biomass and the most wide-ranging was *H. tasmanica* which occurred in intertidal and subtidal zones (Table 1, Fig. 3). At many of the subtidal sites it was the only species found. The next most common species, *Z. muelleri*, was restricted to intertidal or shallowly-subtidal sites (Table 1, Fig. 3). It was found in association with *L. cylindrocarpa* in areas of greatest exposure (Fig. 3). *L. cylindrocarpa* was also found in monospecific stands in the pools and watercourses on the northern and western sides of the bay. *H. ovalis* (Table 1, Fig. 3) was found only at the deeper northern sites in association with *H. tasmanica*, and at sites 27, 29, 30, 33 and 36 was present in greater abundance than *H. tasmanica*. *R. megacarpa* was found in the Yarram Creek area and growing in the creek itself, but was not found at any of the sampling sites.

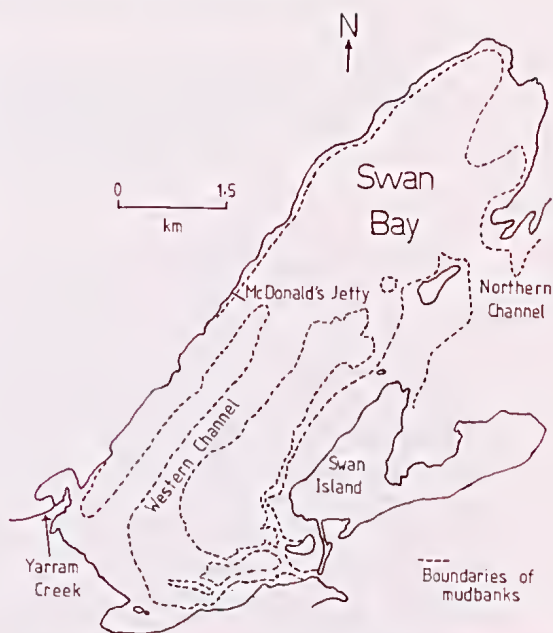


Fig. 1B—Location of mudbanks, channels and other features of Swan Bay.

A total of 74 taxa of invertebrates was recorded. Of these, 39% were polychaetes, 35% crustaceans and 18% molluscs. The ten most common taxa accounted for nearly 80% of animals taken (Table 2). Detritivores dominated both number of taxa and individuals (Table 3). Diversities and numbers of taxa were lower at



Fig. 2—Sampling points for survey of vascular hydrophytes (●) and invertebrates (▲) within Swan Bay.

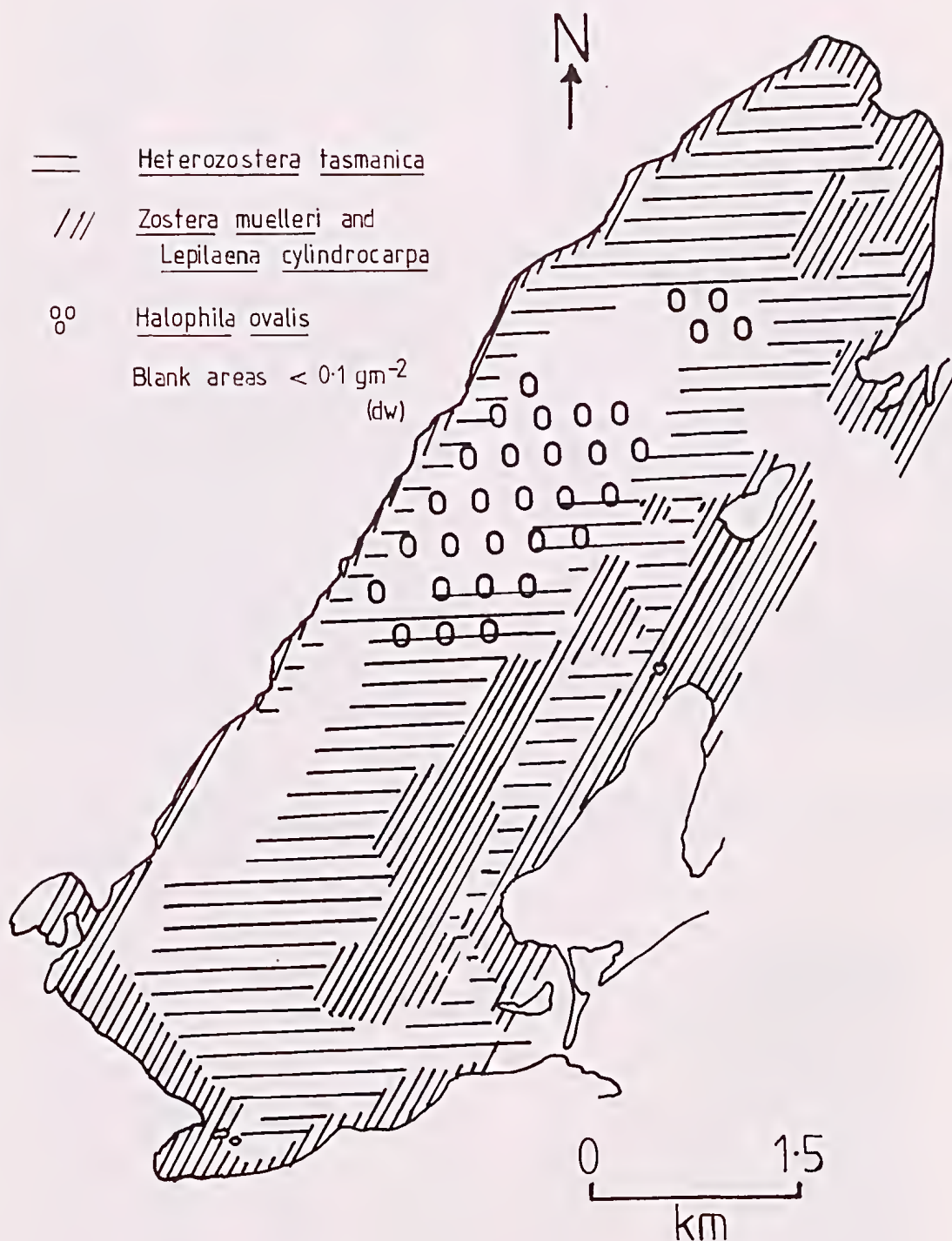


Fig. 3—Distribution of vascular hydrophytes within Swan Bay

TABLE 1
BIOMASS AND DISTRIBUTION OF VASCULAR HYDROPHYTES

Species	Mean dry weight (g m ⁻²)	Upper limit (g m ⁻²)	% of total dry weight	% of sites at which found
<i>Heterozostera tasmanica</i>	103.5	405	73.8	90
<i>Zostera muelleri</i>	44.2	151	15.4	44
<i>Lepilaena cylindrocarpa</i>	16.4	71	5.7	36
<i>Halophila ovalis</i>	15.4	66	3.1	22

ungrassed sites, while the number of individuals per sample was higher at these sites (Table 4).

Hierarchical analysis reflected the differences in community statistics. Both indices fused the sites into two groups, one comprising the two sparsely-grassed sites, the other formed by the heavily-grassed sites (Figs 4A, B). The similarity of the results from both indices indicates that both species composition and numbers contributed to the differences between the two groups of sites. No major differences were shown between the heavily-grassed sites indicating the general evenness of the intertidal seagrass community of Swan Bay.

DISCUSSION

This study provides quantitative data on the biomass of vascular hydrophytes from an area within Port Phillip Bay. It supports the qualitative work of Bulthuis (1981a) which showed that in almost all areas of the bay where vascular hydrophytes grow, *H. tasmanica* was the

major species. Bulthuis (1981b) has reported biomass data for *H. tasmanica* in Westernport Bay. However, the samples were taken in summer (compared with winter/spring in this study) and the sampling procedures were different.

The intertidal vascular hydrophytes of Swan Bay support a polychaete-crustacean-mollusc community dominated by detritivores. This dependence on the detrital pathway is a feature of temperate seagrass beds (Kikuchi 1980). There were differences between heavily-grassed and sparsely-grassed sites within Swan Bay; the latter showed either marked decreases in the abundance or complete absence of many of the commoner infaunal species. Similar depauperation of the infauna has been shown in other seagrass communities: *Z. marina* L. (Orth 1973), *Z. capricorni* Asechers. (Hutchings & Recher 1974, Hutchings *et al.* 1978, Rainer & Fitzhardinge 1981). All these authors found higher diversities and abundances in seagrasses than in nearby bare sediment. The higher total densities at ungrassed sites in Swan Bay were mainly due to the

TABLE 2
TAXA FROM TOTAL SAMPLE RANKED BY NUMBER OF INDIVIDUALS
Key to taxa: C = Crustacean; P = Polychaete; and, M = Mollusc

Species	Number	Cumulative %	Taxa
<i>Allorchestes compressa</i>	2846	21.3	C
<i>Capitella capitata</i>	2300	34.1	P
<i>Zeacumantus diemenensis</i>	1516	42.5	M
<i>Paracorophium</i> sp.	1441	50.5	C
<i>Ceratonereis pseudoerythraensis</i>	1140	56.8	P
<i>Scoloplos cylindrifer</i>	1094	62.8	P
<i>Heteromastus filiformis</i>	872	67.9	P
<i>Leptochelia ignota</i>	761	71.9	C
<i>Corophium</i> sp.	702	75.8	C
<i>Austrocochlea constricta porcata</i>	511	78.6	M
<i>Amphithoe</i> sp.	478	82.3	C
<i>Armandia intermedia</i>	335	83.1	P
<i>Paracallioppe australis</i>	332	85.0	C
<i>Tellina deltoidalis</i>	328	86.8	M
<i>Nemertean</i> s, unidentified	328	88.3	
<i>Brachynotus spinosus</i>	178	89.3	C
<i>Platynympha longicaudata</i>	156	90.2	C
<i>Amarinus laevis</i>	140	90.9	C
<i>Anthozoan</i> sp. 1	124	91.6	
<i>Prionospio multipinnulata</i>	116	92.3	P

TABLE 3

NUMBER AND PERCENTAGES OF TAXA AND INDIVIDUALS IN VARIOUS FEEDING GROUPS. s = number of taxa,
n = number of individuals

Trophic group	s	%s	n	%n
Herbivore	5	6.4	632	3.5
Detritivore	34	43.6	13559	74.4
Predator	18	23.1	785	4.3
Omnivore	7	9.0	1496	8.2
Scavenger	4	5.1	159	0.9
Suspension feeder	6	7.7	1489	8.2
Unspecified	4	5.1	108	0.6

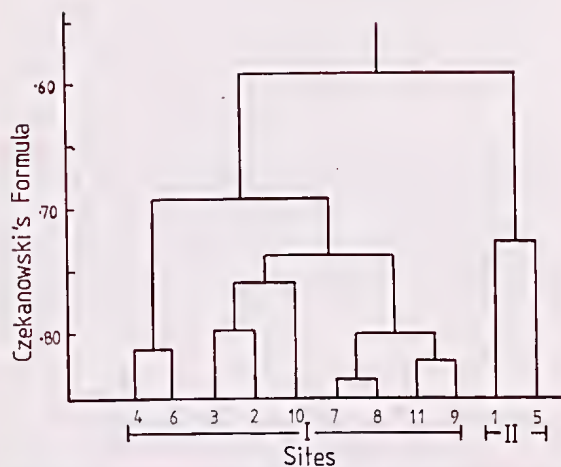


Fig. 4A—Invertebrate sampling sites grouped by hierarchical classification using Czekanowski's formula.

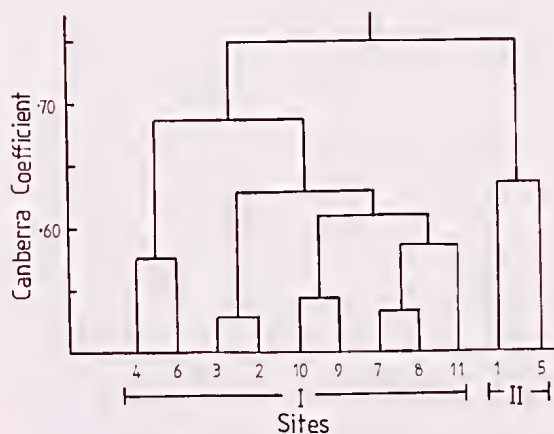


Fig. 4B—Invertebrate sampling sites grouped by hierarchical classification using the Canberra metric coefficient.

TABLE 4

COMMUNITY STATISTICS FOR BENTHIC SITES. Sparsely grassed sites marked with an asterisk (*). See text for explanation of symbols.

Site	H'	J'	S	s	n
1*	2.15	0.65	28	15.8	227.5
2	2.46	0.68	38	21.8	148.6
3	2.21	0.60	39	19.5	142.0
4	2.63	0.70	43	24.0	143.5
5*	2.07	0.62	28	16.0	302.3
6	2.61	0.72	37	20.6	95.0
7	2.32	0.63	40	22.0	221.7
8	2.56	0.67	47	32.9	220.3
9	2.34	0.61	47	22.8	197.4
10	2.32	0.68	31	20.5	122.0
11	2.56	0.64	55	27.2	216.5

$$H' = 2.38 \pm 0.18 \quad J' = 0.65 \pm 0.04 \quad S = 39 \pm 8$$

TABLE 5
COMPARISON OF COMMUNITY STATISTICS FOR A RANGE OF AUSTRALIAN SEAGRASS COMMUNITIES.
SEE TEXT FOR EXPLANATION OF SYMBOLS

Authors	Site	Seagrass	H'	J'	S	N
Rainer & Fitzhardinge (1981)	Cabbage Tree Basin N.S.W.	<i>Z. capricorni</i>	1.31	0.46	87	8760
Poore (1982)	Gippsland Lakes (Site 13)	<i>P. australis</i>	1.99	0.73	94	2780
Watson <i>et al.</i> (1984)	Westernport Bay	<i>Z. muelleri</i>	2.45	0.76	54	20-25,000
Collett <i>et al.</i> (1984)	(a) Crib Point	<i>Z. muelleri</i> & <i>H. tasmanica</i>	2.91*	—	56	2097
	(b) Rhyll	<i>Z. muelleri</i> & <i>H. tasmanica</i>	2.93†	—	72	1984
	Forster (NSW)	<i>P. australis</i>	3.95	—	39	597
	Shoal Bay	<i>P. australis</i>	4.67	—	100	4629
Present study	Swan Bay	<i>Z. muelleri</i>	2.45‡	0.66	74	5437‡
		<i>H. tasmanica</i>				
		<i>L. cylindrocarpa</i>				

* mean of two transects (24 sites); † mean of one transect (12 sites); ‡ mean of 9 sites

presence of large numbers of a few species of opportunistic crustaceans (including *Corophium* sp. and *Paracorophium* sp., Dorsey 1982). These two species are subject to irregular population fluctuations and are not a consistent component of the benthic fauna.

A number of the common species in Swan Bay are considered to be estuarine and are prevalent in other parts of Port Phillip Bay (Poore & Kudenov 1978a, b). These include *Scoloplos cylindris*, *Corophium* sp. and *Amarinus laevis*. Some of the other common species have been recorded from estuarine areas on the south-eastern coast of Australia including *Tellina deltoidealis* and *Armandia intermedia* (Hutchings *et al.* 1978, Rainer & Fitzhardinge 1981, Poore 1982). A number of the estuarine species found in Swan Bay (*Capitella capitata*, *Corophium* sp.) are opportunistic (Dorsey 1982, Grassle & Grassle 1974) and so are able to take advantage of changed conditions.

Swan Bay shows both structural similarities to and differences from seagrass communities studied elsewhere in Australia. The proportion of taxa in each trophic level is similar to those reported in beds of *Posidonia australis* in N.S.W. (Collett *et al.* 1984) and *Z. capricorni* in an estuary in N.S.W. (Rainer & Fitzhardinge 1981). Community statistics were also used to compare the Swan Bay community to other Australian seagrass communities. Differences in sampling methods and sampling intensities make comparison of community abundance and diversity statistics difficult (Rainer & Fitzhardinge 1981). However, some general trends can be indicated by such comparisons. Table 5 lists community statistics for a number of south-eastern Australian seagrass communities. Diversities ranged from a low of 1.31 in the estuarine Cabbage Tree Basin to a high of 4.67 in a marine *Posidonia* meadow at Shoal Bay. The diversity for Swan Bay falls mid-way between these values and is comparable to the values for other Victorian sites. Species abundances varied greatly between sites with Swan Bay again in the mid-region for these values, as with the number of species found at each site. In terms of community structure, as shown by a number of community statistics, Swan Bay supports a moderately-diverse macrobenthic community comparable in structure to other such communities in southeastern Australia.

Despite the similarities in trophic and community structure, the species composition of the Swan Bay benthic community is different from those of the other communities mentioned above. Many of the species found in Swan Bay are either missing or found only rarely at the other sites. Hutchings (1982) noted the lack of 'characteristic' seagrass communities so far described in Australia. In a study of *Posidonia* meadows in N.S.W. (Collett *et al.* 1984), different sites were found to support communities of differing species. These compositional differences were thought to be mainly due to salinity differences between sites. Rainer and Fitzhardinge (1981), reviewing the faunal communities of estuarine *Z. capricorni* beds in N.S.W., found that a number of species were common to different sites but that dominant species varied from site to site. The community of *H. tasmanica* and *Z. muelleri* beds in Westernport Bay

described by Watson *et al.* (1984) has a range of species that are also found in Swan Bay, but the dominant species were different. Two of the dominant species in Westernport Bay (*Nephyts* and *Callianassa*) were not taken from Swan Bay. Similarly a *Z. muelleri* bed in the Gippsland Lakes (Poore 1982) had few dominant species in common with Swan Bay. These differences indicate that, as with communities associated with *P. australis* and *Z. capricorni*, there is no characteristic *Z. muelleri* or *H. tasmanica* community. Each site supports a faunal community that is determined by a range of environmental conditions of which the presence of seagrass is only one.

This study has produced quantitative data on the biomass of vascular hydrophytes of Port Phillip Bay. Like Westernport Bay, *H. tasmanica* is the dominant vascular hydrophyte present. The plant cover is shown to influence benthic macrofauna, the fauna of Swan Bay being apparently characteristic for the area and not particularly similar to other *Heterozostera-Zostera* communities in Victoria.

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